

Keithley 179 A

Instruction Manual Model 179A TRMS Multimeter

SPECIFICATIONS

DC VOLTS

RANGE	RESOLUTION	ACCURACY (1 YEAR)	MAXIMUM ALLOWABLE INPUT
		18°-28°C ± (%rdg + digits)	
200mV	10 µV	0.04% + 3d	1200V†
2 V	100 µV	0.04% + 1d	1200V†
20 V	1mV	0.04% + 1d	1200V†
200 V	10mV	0.04% + 1d	1200V†
1200 V	100mV	0.04% + 1d	1200V†

†For 10 seconds. ‡Continuous.

TEMPERATURE COEFFICIENT (0°-18°C & 28°-55°C): ± (0.006% + 0.2d)/°C except ± (0.006% + 0.4d)/°C on 200mV range.

INPUT RESISTANCE: 10MΩ ± 0.1%.

NORMAL MODE REJECTION RATIO: Greater than 60dB at 50Hz and 60Hz.

COMMON MODE REJECTION RATIO (1kΩ unbalance): Greater than 120dB at DC, 50Hz and 60Hz.

SETTLING TIME: 1 second to within 1 digit of final reading.

AC VOLTS

RANGE	RESOLUTION	ACCURACY (1 YEAR)	TEMPERATURE COEFFICIENT	
		(above 2000 counts) 18°-28°C; 100Hz-10kHz ± (%rdg + digits)	0°-18°C & 28°-55°C ± (%rdg + digits)/°C	
200mV	10 µV	0.7% + 15d	0.07% + 2d	0.15% + 3d
2 V	100 µV	0.6% + 15d	0.07% + 2d	0.15% + 3d
20 V	1mV	0.5% + 15d	0.05% + 2d	0.05% + 2d
200 V	10mV	0.5% + 15d	0.05% + 2d	0.05% + 2d
1000 V	100mV	0.5% + 15d	0.05% + 2d	0.05% + 2d

EXTENDED FREQUENCY ACCURACY:

(45Hz-100Hz): ± (0.7% + 15d).

(10kHz-20kHz): ± (0.8% + 15d) on 20V and higher ranges;

± (1.5% + 15d) on 2V range;

± (2% + 15d) on 200mV range.

RESPONSE: True root mean square.

CREST FACTOR (ratio of peak value to rms value): 3:1.

INPUT IMPEDANCE: 1MΩ shunted by less than 75pF.

MAXIMUM ALLOWABLE INPUT VOLTAGE: 1000V rms, 1400V peak, 10⁷V•Hz maximum.

COMMON MODE REJECTION RATIO (1kΩ unbalance): 60dB at DC, 50Hz and 60Hz.

SETTLING TIME: 2 seconds to within 15 digits of final reading.

DC AND TRMS AC AMPS

RANGE	RESOLUTION	ACCURACY (1 YEAR)		MAXIMUM VOLTAGE	SHUNT RESISTANCE
		18°-28°C ± (%rdg + digits)	AC 45Hz-10kHz (above 2000 cts)		
200 µA	10 nA	0.2% + 2d	1% + 15d	0.2 V	1 kΩ
2mA	100 nA	0.2% + 2d	1% + 15d	0.2 V	100 Ω
20mA	1 µA	0.2% + 2d	1% + 15d	0.2 V	10 Ω
200mA	10 µA	0.2% + 2d	1% + 15d	0.25V	1 Ω
2000mA	100 µA	0.2% + 2d	1% + 15d	0.6 V	100mΩ
20 A	1mA	0.5% + 2d*	1% + 15d†	0.5 V	10mΩ

*Add 0.1%rdg above 15A for self-testing.

†1kHz max.

MAXIMUM INPUT: 2A, 250V DC or rms (fuse protected) except for 20A range: 15A continuous, 20A for 1 minute (unfused).

TEMPERATURE COEFFICIENT (0°-18°C & 28°-55°C):

DC ± (0.01% + 0.2d)/°C.

AC ± (0.07% + 2d)/°C.

CREST FACTOR (ratio of peak value to rms value): 3:1.

SETTLING TIME: DC: 1 second to within 1 digit of final reading. AC: 2 seconds to within 15 digits of final reading.

OHMS

OHMS		ACCURACY (1 YEAR)		MAXIMUM VOLTAGE		TEMPERATURE COEFFICIENT		NOMINAL	
RANGE	RESOLUTION	18°-28°C		ACROSS UNKNOWN		0°-18°C & 28°-55°C		APPLIED CURRENT	
		± (%rdg + digits)		ON RANGE		± (%rdg + digits)/°C			
		HI Ω	LO Ω	HI Ω	LO Ω	HI Ω	LO Ω	HI Ω	LO Ω
2 kΩ	100mΩ		0.15% + 15d		0.2V		0.02% + 2d		100 μA
20 kΩ	1 Ω	0.04% + 1d	0.15% + 15d	2V	0.2V	0.003% + 0.2d	0.02% + 2d	100 μA	10 μA
200 kΩ	10 Ω	0.04% + 1d	0.15% + 15d	2V	0.2V	0.003% + 0.2d	0.02% + 2d	10 μA	1 μA
2000 kΩ	100 Ω	0.04% + 1d	0.15% + 15d	2V	0.2V	0.003% + 0.2d	0.03% + 2d	1 μA	0.1μA
20MΩ	1 kΩ	0.10% + 1d		2V		0.02 % + 0.2d		0.1μA	

MAXIMUM ALLOWABLE INPUT: 1kV DC or peak AC for 10 seconds, 450V rms continuous.

MAXIMUM OPEN CIRCUIT VOLTAGE: 5V.

SETTLING TIME: 1 second to within 1 digit of final reading except 2 seconds on 20MΩ range. Ohms settling time is specified for on-scale readings. 20MΩ is 5s for overrange to on-scale readings.

GENERAL

DISPLAY: Five 0.5" LED digits, appropriate decimal position and polarity indication.

CONVERSION PERIOD: 400ms.

OVERRANGE INDICATION: Display blinks all zeroes above 19999 counts.

MAXIMUM COMMON MODE VOLTAGE: 1400V peak.

ENVIRONMENT: Operating: 0°-55°C, 0% to 80% relative humidity up to 35°C. Storage: -25°C to +65°C.

POWER: 105-125V or 210-250V (switch selected), 90-110V available. 50-60 Hz, 5.5W. Optional 6-hour battery pack, Model 1788.

DIMENSIONS, WEIGHT: 85mm high × 235mm wide × 275mm deep (3 1/2" × 9 1/4" × 10 3/4"). Net weight 1.8kg (4 lbs.).

ACCESSORIES SUPPLIED: Instruction Manual and Model 1691 Test Leads.

ACCESSORIES AVAILABLE:

Model 1010: Single Rack Mounting Kit
Model 1017: Dual Rack Mounting Kit
Model 1301: Temperature Probe
Model 1600A: High Voltage Probe (40kV)
Model 1651: 50-Ampere Current Shunt
Model 1681: Clip-On Test Lead Set
Model 1682A: RF Probe
Model 1683: Universal Test Lead Kit
Model 1684: Hard Shell Carrying Case
Model 1685: Clamp-On AC Probe
Model 1691: General Purpose Test Lead Set
Model 1788: Rechargeable Battery Pack
Model 1792: Isolated BCD Output
Model 1793: Isolated IEEE-488 Output
Model 7008-3: IEEE-488 Cable (3 ft.)
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SECTION 1

GENERAL INFORMATION

1.1 INTRODUCTION

The Model 179A is a precision 4½ digit TRMS multimeter useful for measurement of AC and DC voltage, AC and DC current and resistance. Ranges and accuracies are listed in the detailed specifications which precede this section. Ranges and functions are selected with front panel push buttons (see Figure 2-2). The decimal point is also positioned by the selected range push button. Polarity of the measured signal is automatically displayed.

1.2 FEATURES

The Model 179A includes the following features:

- TRMS AC measurement capability gives waveform-insensitive measurement accuracy to applications such as solid-state regulator design, measurement of power transformer input currents and capacitor ripple currents.
- AC and DC CURRENT ranges allow continuous measurements of up to 15A or periodic measurement up to 20A.
- 10µV AC and DC sensitivity
- HI-LO Ohms. In the HI mode, enough voltage can be applied to semiconductors to turn them on for a test. LO can be used for in-circuit measurements without turning on semiconductor junctions. Full-scale compliance voltage is 2V on HI, 200mV on LO.
- 1kV protection on Ω. 1000V overload protection on ohms eliminates accidental damage due to improper function selection.
- Optional BCD output. The Model 1792 Isolated BCD Output may be ordered and is field installable.
- Optional IEEE-488 data output. The Model 1793 IEEE-488 Interface can be ordered with the unit, or can be easily field-installed with a screwdriver. It is powered internally from the instrument. With the interface and any of the low cost controllers now on the market, it is possible to set up an economical, automated test system that saves the time of manually recording, transcribing and entering large amounts of measurement data.

1.3 WARRANTY INFORMATION

Warranty information is provided on the inside front cover of this manual. If there is a need to exercise the warranty, contact the Keithley representative in your area to determine the proper action to be taken. Keithley maintains complete repair and calibration facilities in the United States, West Germany, Great Britain, France, the Netherlands, Switzerland and Austria. Information concerning the application, operation or service of your instrument may be

directed to the applications engineer at any of the previously mentioned locations. Check the inside front cover of this manual for addresses.

1.4 MANUAL ADDENDA

Improvements or changes to this manual will be explained on an addendum included with this manual.

1.5 SAFETY SYMBOLS AND TERMS

Safety symbols used in this manual are as follows:

The symbol  on the instrument denotes that the user should refer to the operating instructions.

The symbol  on the instrument denotes that 1000V or more may be present on the terminal(s).

The **WARNING** used in the manual explains dangers that could result in personal injury or death.

The **CAUTION** used in this manual explains hazards that could damage the instrument.

1.6 UNPACKING AND INSPECTION

The Model 179A is inspected both mechanically and electrically before shipment. Upon receiving the Model 179A unpack all items from the shipping container and check for any obvious damage that may have occurred during transit. Report any damage to the shipping agent. Retain and use the original packaging materials if reshipment is necessary. The following items are shipped with all Model 179A orders:

- A Model 179A TRMS Multimeter
- A Model 179A Instruction Manual
- A Model 1691 General Purpose Test Lead Set
- Optional accessories per request

1.7 OPTIONAL ACCESSORIES

A wide range of accessories are available to facilitate the use of the Model 179A DMM, extend its range, and adapt it for additional uses.

1. Model 1010 Single Rack Mounting Kit—To mount one bench DMM in a standard 5¼" × 19" rack mounting.
2. Model 1017 Dual Rack Mounting Kit—To mount two bench DMMs in a standard 5¼" × 19" rack mounting.
3. Model 1301 Temperature Probe—A rugged low cost temperature probe designed to allow precision temperature measurements from -55°C to 150°C.

Range: -55°C to 150°C

Output: 1mV/°C; compatible with any DMM with at least 10M Ω input impedance

Accuracy: $\pm 2^\circ\text{C}$ from 0° to 100°C; $\pm 3^\circ\text{C}$ from -55° to 0°C and 100° to 150°C

Power: 9V alkaline or C-Zn (NEDA 1604) battery.

4. Model 1600A High Voltage Probe extends the DMM to 40kV.

Maximum Input: 40kV DC or peak AC to 300Hz

Input Resistance: 1000M Ω

Division Ratio: 1000:1 (into 10M Ω)

Ratio Accuracy (into 10M Ω DMM): $\pm 2.5\%$ from 1kV to 40kV DC; -3dB at 300Hz AC

Operating Temperature: 0° to 50°C

5. Model 1651 50-Ampere Current Shunt—The external 0.001 Ω $\pm 1\%$, 4-terminal shunt permits current measurements from 0-50A DC and 20-50A AC.

6. Model 1681 Clip-On Test Lead Set contains two leads, 1.2m (48 inches) long terminated with banana plugs and spring action clip-on probes.

7. Model 1682A RF Probe permits voltage measurements from 100kHz to 250MHz.

AC to DC transfer accuracy: $\pm 1\text{dB}$ from 100kHz to 250MHz at 1V, peak responding, calibrated in rms of a sine wave, compatible with instruments with 10M Ω input resistance

Voltage Range: 0.25V to 15V rms

Maximum Allowable Input: 42V AC peak, 200V (DC + AC peak)

8. Model 1683 Universal Test Lead Kit consists of two test leads. 1.2m (48 inches) long with 12 screw-in tips, 2 banana plugs, 2 spade lugs, 2 alligator clips with boots, 2 needle tips with chucks and 4 heavy duty tip plugs.

9. Model 1684 Hard Shell Carrying Case—Hard vinyl case, 100mm $\times$ 300mm $\times$ 350mm (4" $\times$ 13" $\times$ 14") has a fitted

foam insert with room for the Model 179A, instruction manual and small accessories.

10. Model 1685 Clamp-On AC Probe measures AC current by clamping onto a single conductor. Interruption of the current path is unnecessary. The Model 1685 detects current by sensing the magnetic field produced by the current flow.

Range: 2, 20 and 200A rms

Accuracy: $\pm 4\%$ of range at 60Hz; $\pm 6\%$ of range at 50Hz

Temperature Coefficient: $\pm 0.05\%/^\circ\text{C}$ on 20A and 200A range; $\pm 0.3\%/^\circ\text{C}$ on 2A range

Maximum Allowable Current: 300A rms

Maximum Conductor Voltage: 600V rms

Conversion Ratio: 0.1V/A rms

11. Model 1691 General Purpose Test Lead Set consists of two 0.91mm (36 inches) test leads with probe tips terminated in banana plugs.

12. Model 1788 Rechargeable Battery Pack provides six hours minimum operation from full charge, recharges within 14 hours and is field installable.

13. Model 1792 Isolated BCD Output provides parallel BCD data output including sign, overrange and busy. Field installable.

14. Model 1793 Isolated IEEE-488 Interface—Field installable option provides isolated data output. Switch-selectable TALK ONLY or ADDRESSABLE modes. Mounts within and powered by the Model 179A. Model 7008 IEEE-488 cable is available.

1.8 SPECIFICATIONS

For Model 179A detailed specifications, refer to the specifications that precede this section.

SECTION 2 OPERATION

2.1 PREPARATION FOR USE

The Model 179A is shipped ready to use. The instrument may be powered from line voltage or from rechargeable batteries (when the optional Model 1788 Rechargeable Battery Pack is installed).

2.1.1 Line Power

The Model 179A is provided with a three-wire line cord which mates with third-wire grounded receptacles. Connect the instrument to AC line power as follows:

1. Set the LINE VOLTAGE switch on the back of the instrument to correspond to line voltage available. Ranges are 105 to 125 volts and 210 to 250 volts AC as shown in Figure 2-1.

CAUTION

Connect only to the line voltage selected. Application of incorrect voltage can damage the instrument.

2. Plug the power cord into a properly grounded outlet.

WARNING

Ground the instrument through a properly grounded receptacle before operation. Failure to ground the instrument can result in severe injury or death in the event of short circuit or malfunction.

2.1.2 Battery Pack Power

The Model 179A may also be operated from rechargeable sealed lead-acid batteries contained in the optional Model 1788 Battery Pack. The battery pack will operate the 179A for up to six hours. Circuits within the battery pack will automatically shut down the instrument when the battery charge is insufficient to maintain accurate readings. Refer to Section 5, paragraph 5.3 for installation procedures.

2.1.3 Battery Charging

After the Model 1788 Battery Pack is installed in the Model 179A it can be charged and recharged as follows:

1. Connect the instrument to line power as described in paragraph 2.1.1.
2. With the power switch off, the battery charge circuitry is automatically energized to charge the battery at the maximum rate. When the battery pack is first installed, or if it is completely discharged, allow it to charge for at least 14 hours.

NOTE

For maximum battery life, do not allow the battery pack to remain completely discharged. Constant charging will not harm either the battery pack or the instrument. Allowing the battery pack to discharge below 7.2V and remain discharged will ruin the battery pack.

3. When the 179A is in use on line power, the battery charger maintains a trickle charge on the battery pack.

2.2 OPERATING INSTRUCTIONS

2.2.1 Environmental Conditions

All measurements should be made at an ambient temperature within the range of 0°C to 55°C, and with a relative humidity of 0% to 80% up to 35°C. For instruments above 35°C derate humidity 3% per °C up to 55°C. If the instrument has been subjected to extremes of temperature, allow sufficient time for internal temperatures to reach environmental conditions. Typically, it takes one hour to stabilize a unit that is 10°C (18°F) out of specified temperature range.

2.2.2 Front Panel Familiarization

The following text and Figure 2-2 provide a brief description of the front panel controls, input terminals and display.

1. ON/OFF - Depressing (in) this push button turns the instrument on for either battery power (if the Model 1788 is installed) or line power. Releasing (out) this push button turns the instrument off.

NOTE

In the OFF position, the Model 1788 (if installed) will be charging if the instrument is connected to line power.

2. AC/DC - This switch is used along with the volts (V) and current (A) functions. Depressing (in) this push button selects AC and releasing (out) this push button selects DC.
3. LO/HI - This feature is used along with the Ω function. The front panel push button selects the LO or HI mode for the 20k Ω , 200k Ω and 2000k Ω ranges. Depressing the push button (in) selects LO and releasing the push button selects HI. On the 2k Ω range the Model 179A is in the LO mode, regardless of the push button position. On the 20M Ω range the Model 179A is in the HI mode, regardless of the push button position.

These adjustments are used only for calibration. They are not intended for adjustment during operation.

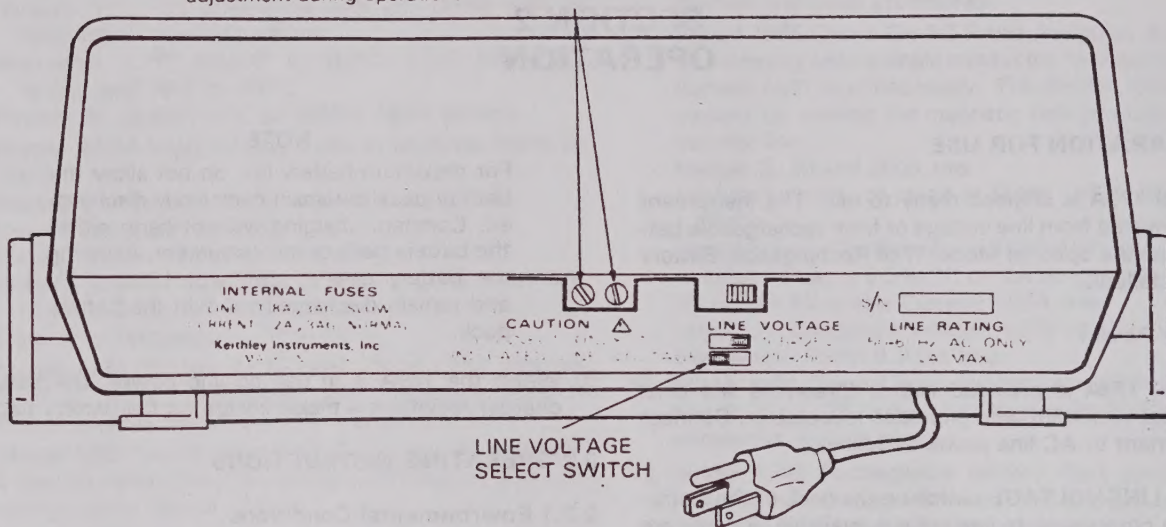


Figure 2-1. Rear View Showing Line Switch

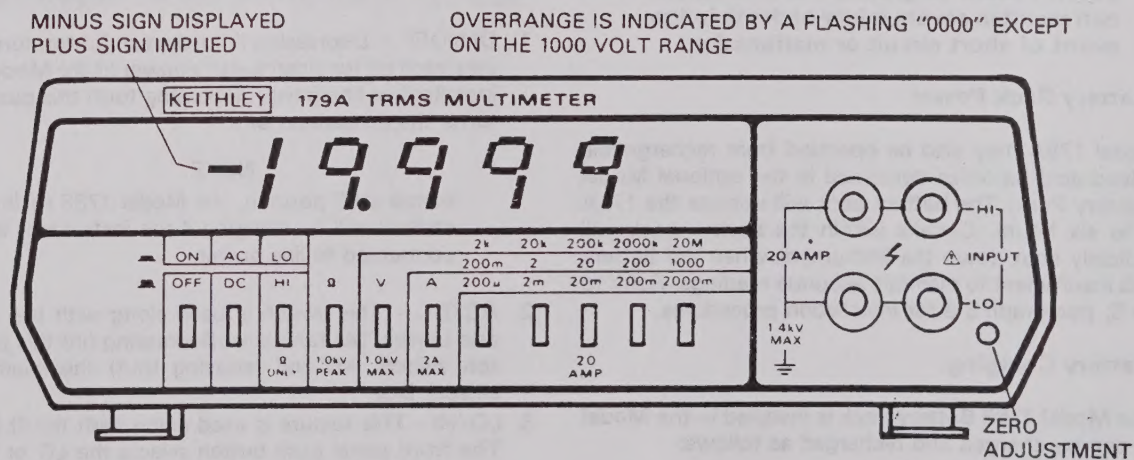


Figure 2-2. Model 179A Front Panel View

- A. Use the HI mode for measurements in the 20k, 200k, 2000k and 20M ranges. Full range voltage drop is 2 volts and is sufficient to cause forward conduction of semiconductor junctions. The HI terminal is positive.
- B. Use the LO mode for measurements in the 2k, 20k, 200k and 2000k ohm ranges. Full range voltage drop is 200mV. Maximum open circuit voltage is 5V on all ranges.

4. Function Selection

- A. Ω - Depressing this push button selects the ohms function.
- B. V - Depressing this push button selects the volts function.
- C. A - Depressing this push button selects the current function.

5. Range Selection - Select the desired range by depressing the appropriate push button.

6. Input

- A. 20 AMP jacks (grey and black) - Use this pair exclusively for measuring current up to 20A.
- B. INPUT jacks (red and black) - Use this pair for current measurements up to 2000mA and all other measurements.

7. Zero Adjustment - The front panel zero adjustment nulls input offset on the 20, 200 and 1200 DC voltage ranges and on all resistance ranges. Typically, this adjustment need not be performed more often than once a week unless the instrument is operated at ambient temperatures outside the range of 18°C to 28°C. Zero the instrument as follows:

- A. Turn on the power and select LO Ω and the 200k range.
- B. Plug in test leads and short them. Adjust the zero adjustment pot on front panel to obtain a reading of 0000 ± 3 digits.

NOTE

The zero adjustment may also be used for lead compensation on a particular Ω range.

2.3 DMM MEASUREMENTS

1. Turn on and zero the instrument as described in paragraph 2.2.2 step 7. Zero the instrument before the first use or whenever the instrument is used outside the temperature range of 18°C to 28°C, and weekly during normal use.
2. TRMS - The Model 179A measures the true root mean square of a signal within the frequency range of 45 to 20kHz. The maximum crest factor for rated accuracy to three.

NOTE

Accuracy is specified for 2000 counts and above. The method of calibrating the converter may yield an offset up to 50 digits with the input shorted. This does not affect the instrument's accuracy.

3. Crest Factor (CF) is the ratio of the peak voltage to the rms voltage. $CF = \frac{V_{PEAK}}{V_{RMS}}$

Some typical crest factors:

Sine wave: $CF = \sqrt{2}$

Square wave: $CF = 1$

Triangular wave: $CF = \sqrt{3}$

Positive pulse train: $CF = 1/\sqrt{\text{duty cycle}}$ (duty cycle for $CF = 3$ is 0.11)

NOTE

There will be some additional measurement error for signals with a crest factor greater than 3 ($CF > 3$).

CAUTION

Do not exceed the maximum allowable inputs of the 179A or instrument damage that is not covered by the warranty, may occur. See Table 2-1 for maximum inputs.

WARNING

Exercise extreme caution when measuring voltage that present a shock hazard hazard to the user. The American National Standard Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30 volts rms or 42.4V peak are present. A good safety practice is to expect that hazardous voltages are present in any unknown circuit to be measured, until actual conditions are verified.

2.3.1 DC Voltage Measurement

1. Select DC V function.
2. Select desired range.
3. Connect the unknown DC voltage to the INPUT jacks of the Model 179A as shown in Figure 2-3.
4. Note reading on display.

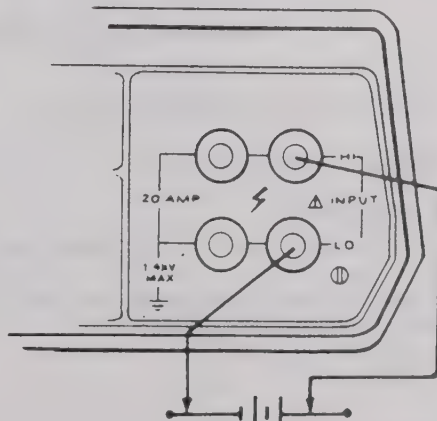


Figure 2-3. DC Voltage Measurement

Table 2-1.  Model 179A Maximum Allowable Inputs

Function	Ranges	Maximum Inputs
DCV	200mV, 2V	450V rms continuous; 1200V peak, for 10 seconds per minute.
	20-1200V	1200V peak.
ACV	All	1000V rms; 1400V peak; $10^7 \text{V} \cdot \text{Hz}$.
DCA, ACA	200 μ A-2000mA	2A, 250V DC or rms (fuse protected)
	20A	15A continuous, 20A for 1 minute (50% duty cycle)
Ω	All	450V rms sine wave; 1000V peak, for 10 seconds per minute.

2.3.2 TRMS AC Voltage Measurement

1. Select AC V function.
2. Select desired range.
3. Connect the unknown AC voltage to the INPUT jacks of the Model 179A as shown in Figure 2-4.
4. Note the reading on display.

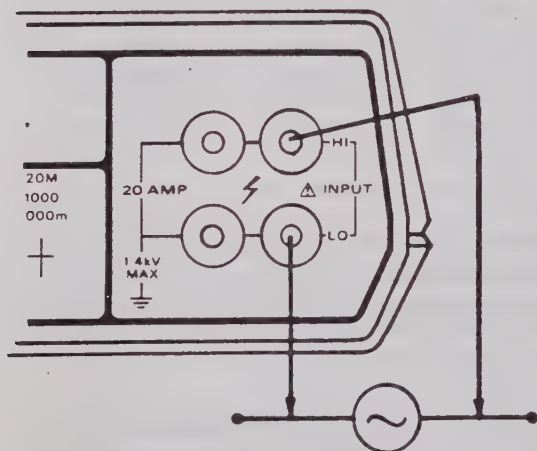


Figure 2-4. AC Voltage Measurement

2.3.3 Resistance (Ω) Measurement

1. Select the Ω function.
2. Select the HI mode or the LO mode (see paragraph 2.2.2 step 3).
3. Connect the unknown resistance (R) to the INPUT jacks of the 179A as shown in Figure 2-5.
4. Note reading on display.

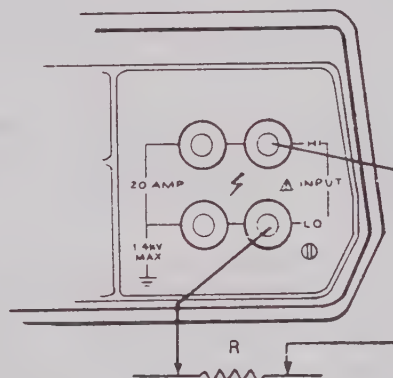


Figure 2-5. Resistance (Ω) Measurement

2.3.4 Current Measurement (DC or TRMS AC)

NOTE

To prevent measurement errors, connect the current test leads to either the 20A jacks or the normal INPUT jacks. Disconnect all circuits from the unused jacks.

WARNING

To prevent electrical shock, remove power from the circuit to be measured before connecting the Model 179A.

1. For current measurements up to 2000mA:
 - A. Select the ACA or DCA function.
 - B. Select the desired range (up to 2000mA).
 - C. Connect the unknown current to the INPUT jacks of the Model 179A as shown in Figure 2-6.
 - D. Note reading on display.
2. For current measurements between 2000mA and 20A:
 - A. Select the ACA or DCA function.
 - B. Depress the 20A range switch.
 - C. Connect the unknown current to the 20 AMP jacks of the Model 179A as shown in Figure 2-7.
 - D. Note the reading on display.

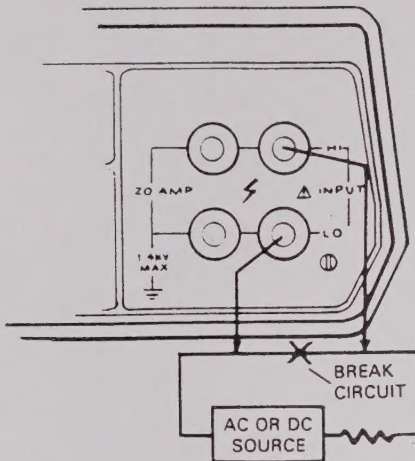


Figure 2-6. Current Measurements Up to 2000mA

NOTE

Up to 15A may be applied continuously without degradation of the measurement due to self-heating effects. For currents between 15A and 20A, specified accuracy can only be obtained when measurements are limited to a 50% duty cycle (i.e., apply the current for a maximum of one minute and then allow at least one minute for cooling before the next measurement).

NOTE

The test leads used must be capable of handling 20A and it is recommended that they be twisted (see Figure 2-7) to minimize external fields which could affect the Model 179A or other equipment. Also, keep the test leads as short as possible to minimize voltage drop.

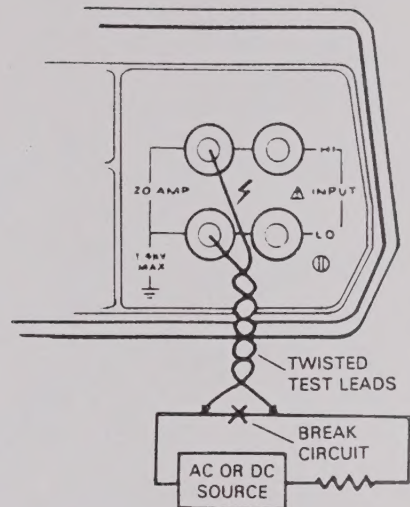


Figure 2-7. Current Measurements Between 2000mA and 20A

2.3.5 AC + DC Measurement

Use the Model 179A to measure TRMS on a signal which has both AC and DC components as follows:

1. Measure and record the TRMS AC component as described in paragraph 2.3.2.
2. Measure and record the DC component as described in paragraph 2.3.1.
3. Compute the rms value from the following equation:

$$E_{RMS} = \sqrt{E_{DC}^2 + E_{AC}^2}$$

